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Case Docket No. FDN-2604

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Sir:

Transmitted herewith for filing is a patent application of:

Inventor(s) : QINYUN PENG, KRISHNA SRINIVASAN AND WILLIAM D. LEE

For : ASPHALT ROOFING COMPOSITE INCLUDING ADHESION  
MODIFIER-TREATED GLASS FIBER MAT

Enclosed are :

☐ DISCLOSURE STATEMENT and List of Prior Art Cited by Applicants & copies of art.

☒ 1 sheet of drawing (informal).

☒ An assignment of the invention to BUILDING MATERIALS INVESTMENT CORPORATION

☐ A certified copy of \_\_\_\_\_ application.

☒ Declaration and Power of Attorney executed 12/23/99, 12/22/99 and 12/23/99

The filing fee has been calculated as shown below:

CLAIMS AS FILED

Number Filed	Number Extra	Rate	Basic Fee
			\$690.00
Total			
Claims	33 - 20 = 13	X \$18.00	234.00
Independent			
Claims	6 - 3	3 X \$78.00	234.00
Multiple dependent claim(s), if any		\$260.00	
Total			\$1158.00

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☒ Any filing fees under 37 CFR 1.16 for presentation of extra claims.

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**FDN-2604**

**ASPHALT ROOFING COMPOSITE INCLUDING  
ADHESION MODIFIER-TREATED GLASS FIBER MAT**

**BACKGROUND OF THE INVENTION**

1. Field of the Invention

This invention relates to asphalt products having enhanced tear strength, and more particularly, to asphalt composites including an adhesion modifier, preferably a polysiloxane treated, glass fiber mats which can meet the current ASTM D-3462 standard for tear strength required of asphalt roofing shingles.

2. Description of the Prior Art

Asphalt is a dark brown or black cementitious material comprised predominantly of bitumens that occur in nature or are obtained as a residue in the refining of petroleum. Asphalt has been used for many years for roofing and road-paving applications to form a water-impermeable barrier between the environment and an underlying surface. However, in its pure state, asphalt is not quite suitable as a water-impermeable barrier since it is brittle in freezing temperatures and fluid in hot temperatures. Accordingly, the prior art has modified the asphalt both in a composition aspect and in combining the asphalt with carriers or reinforcing materials so as to provide asphaltic products with the desirable properties of tear strength, flexibility, stability and the like.

Presently, the ASTM D-3462 standard for tear strength for asphaltic roofing composites or shingles is met by the industry by increasing the weight of the mat and/or asphalt in the shingle, and by modification of urea-formaldehyde binders used therein, both of which methods are costly to the manufacturer.

Accordingly, an object of the present invention is to provide an asphalt roofing composite with glass fiber mats having enhanced tear strength, and particularly asphalt roofing shingles which can be in compliance with ASTM D-3462, without requiring an increase in the weight of the shingle or of modifying conventional binders used therein.

### **SUMMARY OF THE INVENTION**

In accordance with this invention, asphalt roofing composites including a glass fiber mat are provided which, in the case of roofing shingles, preferably meet ASTM D-3462 roofing shingle standards for tear strength.

The fiber mat is particularly characterized by including, by weight:

about 68% to about 90% of glass fibers; about 10% to about 32% of an organic resin binder, such as urea-formaldehyde; and about 0.001% to about 20%, preferably about 0.01% to about 10%, of an adhesion modifier, preferably a polysiloxane.

The adhesion modifier induces fiber pull-out during tear of the composite and provides improved composite tear strength.

When tested in accordance with ASTM D-3462, the shingle of this invention is characterized by a substantial number of pull-out fibers in the break area.

This invention also encompasses a process for the preparation of such adhesion modifier-treated fiber mats and asphalt roofing composites therewith, such a process includes the conventional steps of dispersing glass

fibers in water along with a dispersing agent, film former or thickener, and a surfactant to obtain a glass fiber slurry; draining the slurry on a mat-forming machine having a mat forming screen, such as those commercially available from Voith or Sandy Hill, to obtain a wet web; transferring the wet web to a first carrier fabric; applying a binder solution, such as urea-formaldehyde, onto the wet web and removing excess binder by vacuum or other means; transferring the wet web onto a second carrier, such as a wire carrier, carrying the wet web into a dryer and then into a curing oven.

The invention process is characterized by coating the mat fibers with adhesion modifier during the process, suitably from an adhesion modifier solution or emulsion which is applied, preferably by spraying or dipping, onto the wet or dry mat before curing. Alternatively, the adhesion modifier solution may be admixed with the binder solution and applied to the wet web along with the binder solution, or sprayed onto the finished mat. In another embodiment, the adhesion modifier is applied to the fibers prior to forming the wet fiber web.

Suitably the treated-mat includes, by weight, about 0.001% to about 20%, preferably about 0.01% to about 10%, and most preferably about 0.1-1% of an adhesion modifier, preferably a polysiloxane, and has a mass of about 60 to 125 g/m<sup>2</sup>.

The thus-treated fiber mat then is coated on one or both sides with conventional asphalt or asphalt compound to form a composite roofing product, as in the manufacture of roofing shingles. The presence of the adhesion modifier in the glass mat of the shingle of this invention can provide an ASTM D-3462 compliant product at conventional weight and without requiring modification of urea-formaldehyde binder used therein.

This invention is hereafter described with respect to a preferred embodiment, i.e., asphalt-impregnated glass mat treated with an adhesion modifier for use in shingles. However, the invention also finds utility in

connection with glass mat for use in other composite roofing products, e.g., facer products, base sheets, mod bits, cap sheets, underlayments, BUR products and the like.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a top plan view illustrating the tear region featuring broken fibers in an untreated asphalt-impregnated glass mat of the prior art.

Figure 2 is a top plan view illustrating the tear region featuring a substantial number of pulled-out fibers in a treated asphalt-impregnated glass mat of the invention.

### **DETAILED DESCRIPTION OF THE INVENTION**

#### **Materials of Construction**

##### **Glass Fiber Mat**

The glass fiber mat used in the present invention comprises, by weight, about 68% to about 90% of glass fibers of suitable length and diameter. Typically, glass fibers having a length of about 3 mm to 130 mm and a diameter of about 5 to about 25 micrometers are used which can be obtained from commercial sources or made by techniques known in the art.

### **Glass Fiber Mat Manufacture**

The glass fibers are dispersed in water with a dispersing agent. If desired, lubricants and defoamers may be added to the water with dispersing and emulsifying agents. The mixture then is agitated well until a homogeneous aqueous slurry of the glass fibers is obtained.

Next, the slurry is transferred to a mat-forming machine, and the liquid component is drained therefrom resulting in a wet fiber web obtained on the machine. The wet fiber web is then transferred to a second carrier fabric having interstices therein and a binder solution is applied thereto. The binder solution is applied to the wet web from a water solution thereof. The binder suitably is an organic resin such as urea-formaldehyde resin or a mixture of urea-formaldehyde resin and known modifiers of urea-formaldehyde resin. The excess of the binder solution is then removed from the wet fiber web by vacuum or other means and the web is transferred to a carrier wire which carries the web into a dryer and a curing oven.

The glass mat contains, by weight, about 10% to about 32% of the organic resin binder.

### **Adhesion Modifier**

Suitable adhesion modifiers for use herein include siloxanes, glycerides, phosphate esters of fatty acids or alcohols, fatty ammonium salts, saponified oils, coconut oil, amines such as polyamines, fatty amines, fatty amine oxides, amido amines, polyamido amines, amine substituted terpenes, polyamides and mixtures of the above with glycerols or glycols. A 10% alkoxylated aliphatic polyamine emulsion in water, and a mixture of 60-90% alkoxylated aliphatic polyamine and 10-40% polyalkylene glycol have also been successfully employed.

Siloxanes useful in the asphalt composite of the present invention are generally classified as polysiloxanes and modified polymers thereof, with various substituents, branching and end-groups thereon, and copolymers thereof.

Suitable siloxanes for use in this invention may be selected from among polyalkyl siloxanes, polyaryl siloxanes, polyalkylaryl siloxanes and polyether siloxane copolymers. Mixtures of these compounds also may be used. Polysiloxanes having a molecular weight of at least 600, or polymerized at elevated temperatures in situ, are preferred to achieve the enhanced tear strength of the asphalt composites herein.

The polysiloxane may be applied in the form of a solution in water or isopropanol, or as an emulsion.

The adhesion modifier can be applied to the web in several alternative processes. In one process, the adhesion modifier is admixed with the binder solution and the mixed solution is applied to the web. In another process, a preferred embodiment, the adhesion modifier is applied by spraying the web immediately after the binder application. Alternatively, the adhesion modifier can be applied to the dried or cured glass fiber mat. In some cases, it is believed that the adhesion modifier can be added to the glass fiber size during fiber manufacture.

#### **Process of Making the Asphalt Roofing Composite**

The process of making the asphalt roofing composite of the present invention comprises the steps of: providing an adhesion-modifier treated glass mat, as described above; coating the glass mat on one or both sides with a conventional asphalt or asphalt compound, and, optionally, roofing granules; and cutting the finished product into desired sizes.

### **Testing of the Composite Asphalt Product**

Tear test D-1922, as referenced in ASTM D-3462 (July 10, 1997 edition), was used to test the tear property of glass fiber mats and shingles made by the present invention.

Briefly, the test measures the force in grams required to propagate tearing across a film or sheeting specimen using a pendulum device. Acting by gravity, the pendulum swings through an arc, tearing the specimen from a precut slit. The specimen is held on one side by the pendulum and on the other side by a stationary member. The loss in energy by the pendulum is indicated by a pointer. The scale indication is a function of the force required to tear the specimen.

The test specimens used were 3 inches in width and 2.5 inches in length.

In the laboratory, the finished fiber mats were coated with an asphalt solution consisting of 32% w/w asphalt having 68% w/w limestone filler. The coating was done on a two-roller coater with the coating poured at about 420°F onto both sides of the finished mat as it was passed vertically through the coater. The target weight was 56 lb/CSF. The finished material was die cut into 2.5 x 3.0 inch Elmendorf Tear specimens to be tested both in machine direction (MD) and cross or transverse direction (CD). All specimens were weighed and those outside the weight limits of  $56 \pm 4$  lb/CSF were not tested.

A control, consisting of the same specimen as the test samples, except not sprayed with the polysiloxane solution, was also prepared.

The results of the testing of asphalt-coated hand sheets and of asphalt roofing shingles containing such treated glass mat are shown in Tables I-5 below.



**TABLE 1**

<u>Code</u>	<u>Polysiloxane*</u>	<u>Mol. Wt.</u>	<u>Tear Strength of Asphalt-Coated Hand Sheet (in gf)</u>		
			<u>Control</u>	<u>Dry Mat</u>	<u>Reheated Mat</u>
L-7210	Polyalkylene oxide-modified polydimethylsiloxane-dimethylsiloxane copolymer	13,000	984	1424	1224
L-7500	Polyalkylene oxide-modified polydimethylsiloxane-dimethylsiloxane copolymer	3,000	984	1105	1244
L-7600	Polyalkylene oxide-modified polydimethylsiloxane-dimethylsiloxane copolymer	4,000	1107	1236	1379
YBD-125	(Carboxylatepropyl)methylsiloxane-dimethylsiloxane copolymer	>1,000	1237	1634	1863
DBP-732	Dimethylsiloxane-(60% PO-40% EO) block copolymer	20,000	1237	1793	1625
CMS-626	(Hydroxyalkyl functional) methylsiloxane-dimethylsiloxane copolymer	5,000	-	1098	1503
AMS-162	Aminopropylmethylsiloxane-dimethylsiloxane copolymer	4,500	1259	1736	1602
ATM 1322	Aminoethylaminopropylmethoxysiloxane-dimethylsiloxane copolymer	>1,000	1218	1551	1712
GP 502	Glycidoxy propyl dimethoxy silyl end blocked dimethyl siloxane polymer	5,000	1017	1169	1510
GP 446	Methacryloxy propyl dimethoxy silyl dimethyl siloxane polymer	40,000	1072	1119	1507
GP 501	Vinyl dimethoxy silyl end-blocked dimethyl siloxane polymer	6,500	1072	1128	1385
GP 134	Aminoethylaminopropyl dimethoxy silyl end blocked dimethyl siloxane polymer	3,800	1237	1532	1684
GP 7100	Amine-alkyl modified methylalkylaryl silicone polymer	7,800	1096	1369	1287
Exp 32	Epoxy functional dimethylpolysiloxane copolymer	8,300	1096	1235	1658
SWS 101	Dimethylpolysiloxane	26,439	1154	1153	1396
ABP-263	Dodecylmethylsiloxane-hydroxypolyalkyleneoxypropyl methylsiloxane copolymer	1,900	1157	1527	1327
ALT-263	(Dodecylmethylsiloxane)-(2-phenylpropylmethylsiloxane) copolymer	>1,000	1154	1495	1305
L-77	Polyalkylene oxide-modified polydimethylsiloxane-dimethylsiloxane copolymer	600	1072	1168	1134

\* A 2% solution in IPA was sprayed onto cured glass mat, dried to remove solvent, and reheated to 300°C for 10 sec.

TABLE 2

Polysiloxane* Code	% Solids	Tear Strength of Asphalt-Coated Hand Sheet (in gf)		
		Control	Dry Mat	Reheated Mat
RCTW 9011	1.4	1129	1253	
RCTW 9130	1.4	1129	1356	
RCTW B9296	1.4	1129	1352	
RCTW B9296	1.4	1028	1224	1485
RCTW B9296	0.14	966	1182	1401
RCTW B9296	0.14	966	1182	1292#
RCTW B9296	0.14	959		1306
RCTW B9296	0.08	959		1145
RCTW B9296	0.04	959		1125

Dry mat: dried at 135°F for 0.5~1 hours. Heated mat: heated at 300°C for 10 seconds.

# heated at 220°C for 15 seconds.

\* Chemtrend, Div. of Castrol, Inc. — mixture of polydimethylsiloxanes, M.W. >1000; 50% solids; as emulsion sprayed onto cured glass mat.

Tear Strength of Asphalt-Coated Hand Sheet (in gf)		
<u>Control</u>	<u>Dry Mat (a)</u>	<u>Reheated Mat (b)</u>
1199	1693	1602
1199	1518	1640
1199	1795	2018
1218	2129	1965
1218	1855	2390

Polysiloxane*	Wt. Ratio of Polysiloxane-to-Binder
Code	
B9296	0.24-to-99.76 binder
B9296	0.48-to-99.52 binder
B9296	0.96-to-99.04 binder
B9296	0.9-to-99.10 binder
B9296	1.8-to-98.20 binder

\* Emulsions were sprayed onto wet glass mats prior to drying and curing.

(a) coated with filled asphalt as received; (b) reheated at 300°C for 10 seconds, then coated with filled asphalt

Tear Strength of Asphalt-Coated Hand Sheet (in gf)		
Control	Dry Mat (a)	Reheated Mat (b)
1218	1369	1544

Polysiloxane* Code	Wt. Ratio of Polysiloxane-to-Binder
89296	1-to-99 binder

\* Emulsion was added to binder system, then sprayed onto wet glass mat.

(a) coated with filled asphalt as received; (b) reheated at 300°C for 10 seconds, then coated with filled asphalt

Tear Strength of Shingle (in gf)	
Control	Dry Mat (a)      Reheated Mat (b)
1552	2207

Polysiloxane* Code	Wt. Ratio of Polysiloxane-to-Binder
39296	1-to-99 binder

Emulsions were sprayed onto wet glass mats prior to drying and curing, and formed into asphalt shingles\*\*.

**D-3462 ASTM standard for tear strength of 1700 gf.**

The results in Tables 1-4 establish that the presence of a polysiloxane in the glass mat substantially improves the tear strength of both the dry and reheated asphalt-coated hand sheet; Table 5 shows a similar effect for asphalt shingles which include such polysiloxane-treated mat. Suitably asphalt shingles have a tear strength of 2207 in gf which is substantially in excess of the 1700 gf required by the ASTM standard of 1700 required of commercial asphalt-roofing shingles.

When torn, the composite roofing products of this invention are characterized by a substantial number of "pull-out" fibers in the break area. The roofing shingle of this invention is characterized by a substantial number of "pull-out" fibers in the break area when tested in accordance with ASTM D-3462. By a substantial number of "pull-out" fibers, it is meant that at least 10, preferably at least 25 and more preferably at least 50 fibers can be counted in the break area having a "pull-out" length portion at least  $\frac{1}{4}$  that of the average fiber length.

While the mechanism of enhancing the tear strength of asphalt roofing shingles by application of an adhesion modifier, e.g., polysiloxane, to the glass fiber mat is not completely understood at present, it is believed that the adhesion modifier modifies the adhesion characteristics between the glass mat and asphalt coating. In accordance with this invention, we unexpectedly observe that adhesion modifier treated asphalt-impregnated glass mats feature a tear region in which the fibers are pulled out, not torn or broken, as with prior art untreated asphalt-impregnated glass mat. It is believed that this mechanism contributes substantially to the energy dissipation during the tear process. Accordingly, the tear from shingles containing adhesion modifier-treated glass mats reveal pulled-out fibers, rather than torn or broken fibers, as observed from shingles with untreated mats as depicted in Figures 1 and 2.

While the invention has been described with particular reference to certain embodiments thereof, it will be understood that changes and modifications may be made which are within the spirit and scope of the invention.

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**WHAT IS CLAIMED IS:**

1. A glass fiber mat for use in a roofing composite, said mat comprising, by weight, about 68% to about 90% of fibers; about 10% to about 32% of an organic resin binder; and about 0.001% to about 20% of an adhesion modifier which induces fiber pull-out during tear of the composite and provides improved composite tear strength.
2. A glass fiber mat according to claim 1 wherein the amount of adhesion modifier is about 0.01% to about 10%.
3. A glass fiber mat according to claim 1 wherein the adhesion modifier is a polysiloxane.
4. A glass fiber mat according to claim 3 wherein said polysiloxane is a polyalkyl siloxane, a polyaryl siloxane, a polyalkylaryl siloxane or a polyether siloxane, or derivative thereof.
5. A glass fiber mat according to claim 4 wherein said polysiloxane is a polydimethyl siloxane or derivative thereof.
6. A glass fiber mat according to claim 4 wherein said polysiloxane has a molecular weight  $> 600$ .
7. A glass fiber mat according to claim 1 wherein said organic resin binder includes a urea-formaldehyde resin.

8. A glass fiber mat of claim 1 wherein said glass fibers have a length of about 3 mm to about 130 mm, and a diameter of about 5 micrometers to about 25 micrometers.

9. A roofing shingle comprising a glass fiber mat including, by weight, about 68% to about 90% of fibers, about 10% to about 32% of an organic resin binder, and about 0.001% to about 20% of an adhesion modifier which induces fiber pull-out when the shingle is torn and provides improved shingle tear strength; and a coating of asphalt or asphalt compound on both sides of the glass fiber mat.

10. A roofing shingle according to claim 9 wherein said amount of adhesion modifier is about 0.01% to about 10%.

11. A roofing shingle according to claim 9 wherein said adhesion modifier is a polysiloxane.

12. A roofing shingle according to claim 11 wherein said polysiloxane is a polyalkyl siloxane, a polyaryl siloxane, a polyalkylaryl siloxane or a polyether siloxane or derivative thereof.

13. A roofing shingle according to claim 11 wherein said polysiloxane is a polydimethyl siloxane or derivative thereof.

14. A roofing shingle according to claim 11 wherein said polysiloxane has a molecular weight  $> 600$ .

15. A roofing shingle according to claim 9 wherein said organic resin binder includes a urea-formaldehyde resin.

16. A roofing shingle according to claim 9 wherein said glass fibers have a length of about 3 mm to about 130 mm, and a diameter of about 5 micrometers to about 25 micrometers.

17. A roofing shingle comprising a glass fiber mat including, by weight, about 68% to 90% fibers, about 10% to about 32% of an organic resin binder, and about 0.001% to about 20% of an adhesion modifier which induces fiber pull-out when the shingle is torn and provides improved shingle tear strength, and a coating of asphalt or asphalt compound on both sides of the glass fiber mat;

said shingle characterized by a substantial number of "pull-out" fibers in the break area when tested in accordance with ASTM D-3462.

18. The roofing shingle of claim 17 wherein said adhesion modifier is selected from the group consisting of siloxanes, glycerides, phosphate esters of fatty acids or alcohols, fatty ammonium salts, saponified oils, coconut oil, amines such as polyamines, fatty amines, fatty amine oxides, amido amines, polyamido amines, amine substituted terpenes, polyamides and mixtures of the above with glycerols or glycols.

19. The roofing shingle of claim 17 wherein said adhesion modifier is a polysiloxane.

20. The roofing shingle of claim 17 wherein said organic resin is a urea-formaldehyde resin.



21. The roofing shingle according to claim 17 wherein said glass fibers have a length of about 3 mm to about 130 mm, and a diameter of about 5 micrometers to about 25 micrometers.

22. In a process for the preparation of a glass fiber mat for use in a roofing composite comprising: (a) dispersing fibers in an aqueous medium containing a dispersing agent to obtain a slurry, (b) draining the slurry on a mat forming machine to obtain a wet fiber web, (c) transferring the wet fiber web to a first carrier fabric, (d) applying a binder solution onto the wet fiber web on said first carrier, (e) removing the excess binder from the wet fiber web, (f) transferring the wet fiber web binder onto a second carrier, and (g) drying/curing the wet fiber web; the improvement which is characterized by applying an adhesion modifier to the fiber mat at any stage in the process after forming the wet fiber web, wherein said adhesion modifier induces fiber pull-out when the composite is torn and provides improved composite tear strength.

23. The process of claim 22 wherein said glass fiber mat comprises, by weight, about 68% to about 90% of fibers; about 10% to about 32% of an organic resin binder; and about 0.001% to about 20% of an adhesion modifier.

24. A process according to claim 23 wherein said adhesion modifier is a polysiloxane selected from the group consisting of a polyalkyl siloxane, a polyaryl siloxane, a polyalkylaryl siloxane, a polyether siloxane or a derivative thereof.

25. A process according to claim 24 wherein the amount of said polysiloxane is about 0.01% to about 10%.

26. A process according to claim 24 wherein said polysiloxane has a molecular weight  $> 600$ .

27. A process according to claim 24 wherein said polysiloxane is a polydimethyl siloxane or derivative thereof.

28. A process according to claim 24 wherein polysiloxane is applied as a solution or emulsion.

29. A process according to claim 24 wherein said polysiloxane is applied before step (g).

30. A process according to claim 24 wherein said polysiloxane is applied after (e) and before (g).

31. A process according to claim 24 wherein said polysiloxane is applied as an emulsion.

32. In a process for the preparation of a glass fiber mat for use in a roofing composite comprising: (a) dispersing fibers in an aqueous medium containing a dispersing agent to obtain a slurry, (b) draining the slurry on a mat forming machine to obtain a wet fiber web, (c) transferring the wet fiber web to a first carrier fabric, (d) applying a binder solution onto the wet fiber web on said first carrier, (e) removing the excess binder from the wet fiber web, (f) transferring the wet fiber web binder onto a second carrier, and (g) drying/curing the wet fiber web; the improvement which is characterized by applying an adhesion modifier to the fibers prior to forming the wet fiber web, wherein said adhesion modifier induces fiber pull-out when the composite is torn and provides improved composite tear strength.

33. A composite roofing product comprising a glass fiber mat comprising, by weight, about 68% to about 90% of fibers; about 10% to about 32% of an organic resin binder; and about 0.001% to about 20% of an adhesion modifier; and a coating of asphalt or asphalt compound on at least one side of said glass fiber mat; said product characterized by a substantial number of pull out fibers in the break area when torn, and wherein said adhesion modifier induces fiber pull-out during tear of the composite and provides improved composite tear strength.

**FDN-2604**

**ASPHALT ROOFING COMPOSITE INCLUDING  
ADHESION MODIFIER-TREATED GLASS FIBER MAT**

Abstract

Enhanced tear strength asphalt roofing composites, e.g., roofing shingles which can meet the current ASTM D-3462 standard for tear strength, include an adhesion modifier treated, preferably a polysiloxane treated, glass fiber mat.

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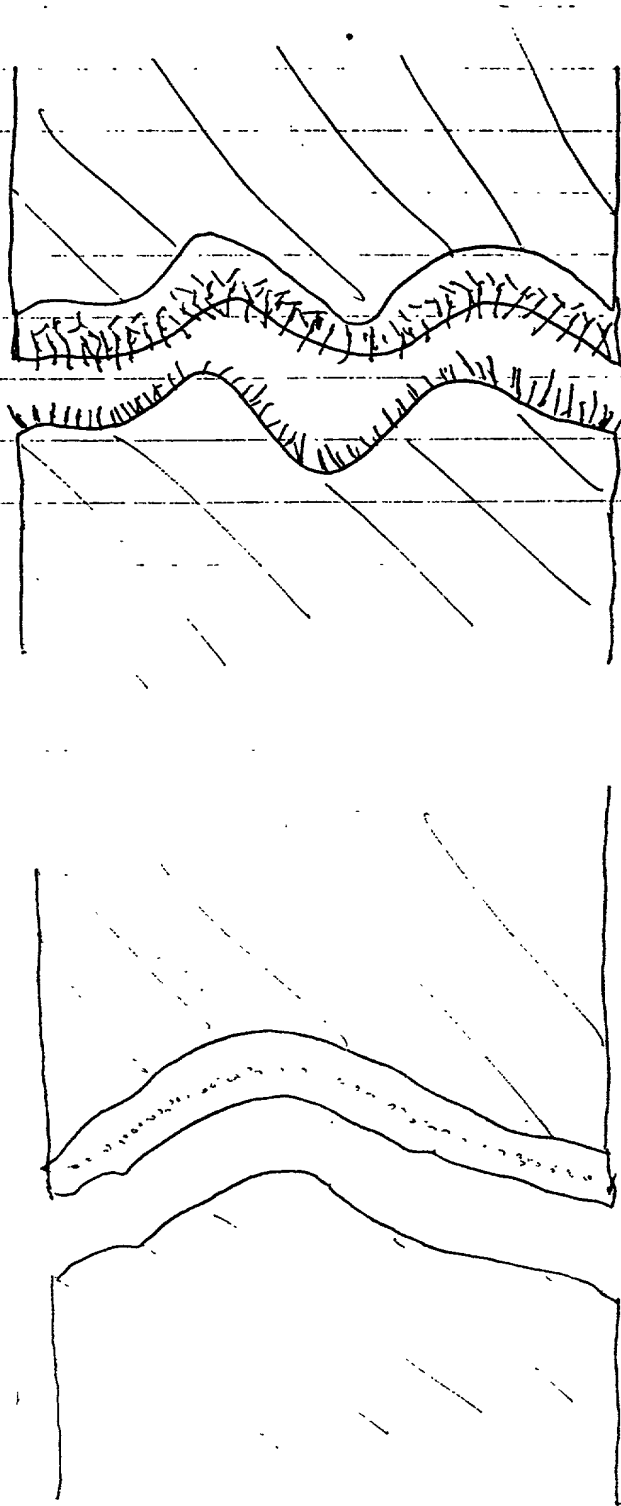


FIG. 1

FIG. 2

(prior art)



I hereby claim benefit under Section 120 of Title 35 of the United States Code of any United States application(s) or PCT application(s) designating the United States identified below and, insofar as the subject matter of each of the claims of this application is not disclosed in said prior application(s) in the manner provided by the first paragraph of Section 112 of Title 35 of the United States Code, I acknowledge my duty to disclose material information of which I am aware as defined in Section 1.56(a) of Title 37 of the Code of Federal Regulations which occurred between the filing date of the prior application(s) and the national or PCT filing date of this application:

Application Serial No. \_\_\_\_\_

Filing Date \_\_\_\_\_

Status \_\_\_\_\_

I hereby appoint:

Dr. Walter Katz, Reg. No. 19,706, William J. Davis, Reg. No. 30,744 and Marilyn J. Maue, Reg. No. 18,869 or either of them as my agent or attorney with full power of substitution and revocation to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

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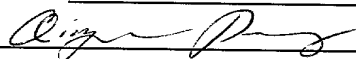
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Full name of first inventor

QINYUN PENG

Inventor's signature



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